Federal Aviation Agency

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ADVISORY CIRCULAR

SUBJECT: INERTIAL NAVIGATION SYSTEMS (INS)

1. PURPOSE. This circular sets forth an acceptable means for complying with rules governing the installation of inertial navigation systems in transport category aircraft. Other criteria which will afford a demonstration of compliance with applicable requirement8 are also acceptable.

2. REFERENCES. Federal Aviation Regulation6 25.1301, 25.1309, 25.1431, and 25.1581.

3. DEFINITIONS. Pot the purpose8 of this advisory circular, the following definitions apply:

a. Inertial Navigation System (INS). A self-contained navigation system which provide6 airplane position and other significant navigation information in response to signals resulting from inertial effect8 on components within the system.

b. Sole Means of Navigation. The navigation system installation used exclusively and without any other navigation data inputs, on which specific operations under the applicable operating rules are predicated.

c. Optional Navigation System. A navigation system not required for safe operation of, or used in the predication of aircraft operations.

4. DISCUSSION. Existing guideline8 for evaluation of airborne navigation systems do not provide adequate criteria for use in determining the airworthiness of INS installations. The criteria contained in this circular are directed toward the unique *features* of INS installation6 and a means of demonstrating compliance with the applicable rules.

5. ACCEPTABLE MEANS OF COMPLIANCE (INS *AS* SOLE MEANS OF NAVIGATION DUFUNG *A* SIGNIFICANT PORTION OF FLIGHT). When installed for use as the sole means of navigation during a significant portion of flight, the INS installation is acceptable under tbe referenced regulations if -

a. it provides, in readily usable form, the following:

(1) valid ground alignment at all latitudes appropriate for intended use of the installation.

(2) a display of alignment status to the flight crew.

(3) the present position of the airplane, in suitable coordinates.

(4) information on destination(s) or waypoint position.

(5) the information needed to gain and maintain desired track and to determine deviation from desired track.

(6) the information needed to determine the estimated time of arrival (ETA).

b. its accuracy in the inertial mode is -

(1) appropriate for the specific air route structures in which it is to be used. Specifically, the INS installation accuracy appropriate for use over the North Atlantic is obtained by limiting cross-track error to a maximum of $\pm$ 20 nautical milts and along-track error to a maximum of $\pm$ 25 nautical milts.

(2) determined on a 95 percent probability basis for flights of typical durations, on selected routes, and at appropriate latitudes (including the highest for which certification is sought), over the representative speed and altitude range. An acceptable combination of laboratory data and flight demonstrations may be used for this determination.

(3) based upon a comparison of INS installation readout at destinations with position fixes obtained by visually sighting ground reference points and/or by using other navigation equipment (such as LORAN, TACAN, VOR, DME, or ground radar).

(4) specified in the airplane flight manual for duration of time representative of intended use.

c. for INS installations that do not have memory or other in-flight alignment means, a separate electrical power source (independent of the main propulsion system) is provided which can supply, for at least 5 minutes, enough power (as shown by analysis and demonstrated in the airplane) to maintain the INS in such condition that its full capability is restored upon reactivation of the normal electrical supply.

d. upon occurrence of reasonably probable failures or malfunctions within the system -

(1) the equipment provides, by visual, mechanical, or electrical output signals, indications of the invalidity of output data, or

(2) the equipment provides such visual, mechanical, or electrical output signals, or devices, as may be required to permit the flight crew to detect significant deviations between similar systems or the invalidity of output data from a single system.

e. a reasonably probable failure or malfunction within the system does not result in loss of the aircraft's required navigation capability.

f. the system alignment and/or navigation computer functions are not invalidated by normal aircraft power interruptions and transients.

g. it is not the source or cause of objectionable radio frequency interference, and is not adversely affected by radio frequency interference from other aircraft systems.

h. the FAA approved airplane flight manual, or supplement thereto, includes pertinent material as required to define the normal and emergency operating procedures and applicable operating limitations associated with INS performance (such as maximum latitude at which ground alignment capability is provided).

6. ACCEPTABLE MEANS OF COMPLIANCE (INS USED WITH OTHER MEANS OF NAVIGATION). When installed for use in association with other navigation services, such as VOR/DME, the INS installation is acceptable under the referenced regulations if it satisfies all conditions set forth in paragraph 5 of this circular, except the one in subparagraph 5.c.

7. ACCEPTABLE MEANS OF COMPLIANCE (INS AS AN OPTIONAL INSTALLATION). When installed as an optional installation, the INS installation is acceptable if -

a. it functions properly in the aircraft.

b. there are no unsafe features.

c. it presents no hazards to the operation of the aircraft.

d. it causes no derogation of performance of systems in other aircraft or ground facilities.

for George S. Moore
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